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Tinwell, Angela; Grimshaw, Mark Nicholas

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# Bridging the Uncanny: An impossible traverse?

Angela Tinwell

*University of Bolton*, [A.Tinwell@bolton.ac.uk](mailto:A.Tinwell@bolton.ac.uk)

Mark Grimshaw

*University of Bolton*, [m.n.grimshaw@bolton.ac.uk](mailto:m.n.grimshaw@bolton.ac.uk)

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# Bridging the Uncanny: An Impossible Traverse?

A. Tinwell

Senior Lecturer

The University of Bolton

Deane Road, Bolton, BL3 5AB

+44 (0)1204 903589

A.Tinwell@bolton.ac.uk

M. Grimshaw

Reader in Creative Technologies

The University of Bolton

Deane Road, Bolton, BL3 5AB

+44 (0)1204 903083

M.N.Grimshaw@bolton.ac.uk

## ABSTRACT

This paper proposes that increasing technological sophistication in the creation of realism for human-like virtual characters is matched by increasing technological discernment on the part of the viewer. One of the goals for achieving a realism that is believable for virtual characters is to overcome the Uncanny Valley where perceived eeriness or familiarity are rated against perceived human-likeness. Empirical evidence shows the uncanny can be applied to virtual characters, yet implies a more complex picture than the shape of a deep valley with a sharp gradient as depicted in Mori's original plot of the Uncanny Valley. Our results imply that: (1) perceived familiarity is dependent upon a wider range of variables other than appearance and behaviour; and (2) for realistic, human-like characters, the Uncanny Valley is better replaced with the notion of an Uncanny Wall because the Uncanny Valley, as a concept, is not fully supported by the empirical evidence but, more importantly as a standard for creating human-like realism, is an impossible traverse.

## Categories and Subject Descriptors

I.3 [Computer Graphics]: Three-Dimensional Graphics and Realism – animation, virtual reality; K.8 [Personal Computing]: General – games.

## General Terms

Design, Human Factors, Theory.

## Keywords

Uncanny Valley, video games, photo-realistic, characters.

## INTRODUCTION

The roboticist Masahiro Mori observed that as a robot's appearance becomes more human-like it is perceived as familiar to a viewer, until finer nuances from human norms caused them to appear eerie, evoking a negative effect for the viewer [25]. The positive relationship Mori identifies between the perceived familiarity for a robot with human-likeness is inverted at certain point where the robot is perceived as more strange than familiar. This sudden negative relationship occurs at the point where the robot appears close to being human and is referred to as the Uncanny Valley. Mori includes corpses, zombies and lifelike

prosthetic hands as examples of things that lie in the Uncanny Valley and predicts that this phenomenon will be even more exaggerated with motion. Mori recommended that to avoid the risk of robots falling into the valley, designers should aspire to the first peak prior to the valley to achieving merely a humanoid appearance, as opposed to the second peak of a total human-likeness.

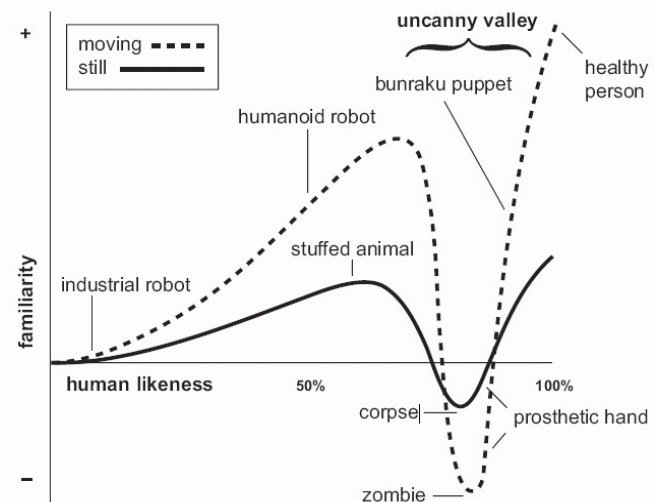


Figure 1. Mori's plot of perceived familiarity against human-likeness as the Uncanny Valley taken from a translation by Karl MacDorman and Takashi Minato of Mori's *The Uncanny Valley* [25].

Since Mori's original theory of the Uncanny Valley in 1970, the concept seems to have remained suspended for nearly 30 years, but has recently reemerged as increasing sophistication in technology allows for increasing realism for both androids and virtual characters [18] [29]. Despite being recognized as a phenomenon that is not only restricted to human-like robots [30] the majority of explanations for the uncanny, with regards to virtual characters, remain untested [4] [18] [29]. Studies that have been carried out since for virtual characters have included the use of still images as stimuli and state that the findings from their studies may not apply to animated faces or bodies thus providing the opportunity to further investigate how motion and sound may exaggerate the uncanny [9] [19] [31] [32]. By implementing unused data from a previous empirical study using videos of virtual characters we attempt to plot the uncanny for such characters [36]. Based on the findings from our study, this paper proposes the theory that, instead of an Uncanny Valley, designers of realistic, human-like characters are faced with an Uncanny Wall, created by the viewers' continually improving

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discernment of the technical trickery used in the character's creation and this discernment prevents complete believability in the human-likeness of that character.

For the purposes of this paper, the term "realism" is used to describe attributes for a character where the designer has intended that it be perceived as realistically human-like and this covers aspects of, and relationships between, appearance, motion, behaviour, sound and, in some cases, context. As some video game developers pursue realism in an attempt to bridge the Uncanny Valley for human-like characters in video games, it can sometimes seem that the more human-like characters become, the more vociferously potential users will object [8]. As users become acclimatized to the current level of technological achievements in approximating realism, it seems users have developed a heightened level of awareness for the attributes that make a character appear *lifeless* as opposed to *lifelike*. For a virtual character, the more that character is intended to be realistic, the less forgiving the viewer is when identifying a difference or strangeness for that character; symptomatic of the uncanny sensation within the context that Freud described for distinguishing between human and non human-like forms [7].

The empirical data collected for our study provided evidence to suggest that realistic human-like characters, proclaimed as overcoming the Uncanny Valley [27], were actually rated as less familiar than a human; implying that they have not yet accomplished this feat. We put forward the idea that increased habituation with the technology used in the attempt to create realistic human-like characters only serves to prompt viewers of differences from the human norm. Accordingly, we propose the Uncanny Wall may never be climbed as the viewer becomes ever more discerning of the use of this technology.

## The Uncanny Sensation

A number of authors have discussed the uncanny as it relates to perceptions of a range of artificial character types. As Minato et al. suggest, the uncanny sensation may not be in response to a single phenomenon, but instead various factors influence how human-likeness is perceived for both appearance and behaviour [24]. They found that on interaction with an android, the uncanny was particularly strong for pre-school children aged between three and five years old, that the uncanny would be stronger for children, as opposed to adults, and that habituation would also lead to a change both in interaction with and perception of the android. Bartnek et al. relate the uncanny as a consequence of a framing effect where, on encountering an android, the expectations raised from selecting our "human-frame" fall short of the data structure that we have stored for this particular frame [3]. The authors suggested that whilst results showed that the framing effect had little impact on the perception of still pictures of robots, the results may differ for the perception of moving robots (for our study, videos were used for all stimuli). Ramey suggests that the uncanny is caused by an overlap of two otherwise separate categories ('human' and 'robot') and it challenges the intuition of one's individual identity or one's humanity, creating a paradox for the features that justify one's existence as human [30]. This idea of conflict or paradox as the root of the uncanny bears similarities to Plantec's use of the theory of cognitive dissonance to explain the uncanny [28]. When confronted with a realistic human-like character, a viewer is prevented from believing that it is real as contradictory beliefs occur to identify flaws and to stop the viewer from being tricked.

The eerie sensation elicited by uncanny robots has been associated with reminding viewers of their own mortality [21] [25]. Building on Rozin's *Theory of Disgust*, (humans instinctively protect themselves from the potential threat of infection) and suggesting that perceived eeriness may be a manifestation of one's own defence mechanisms [31], MacDorman conducted an empirical study, using methods of terror management research, to investigate whether uncanny robots elicit a fear of death [21]. Whilst the results from the study were favourable to this hypothesis, MacDorman also suggests that other factors may still contribute to the uncanny such as "expectations elicited by the human form". Ho et al. identified that the emotion term *fear* has also been identified as a strong predictor of the uncanny sensation for robots [12]. Based on the results of a previous empirical study, Tinwell also identified that *fear* can be associated not only with virtual characters intended to contest a sense of the real such as zombies, but also uncanny protagonist characters who may not have been intended to evoke such a negative reaction [37], for example, Mary Smith by Quantic Dream [35]. These findings imply that the initial *wow factor* reaction that realistic human-like characters can receive, such as the Emily Project [6], may be replaced with a potential *fear factor* as an underlying sensation of discontent grows for the character. Thus, realistic human-like characters intended to be used as protagonists within a game may risk evoking a negative emotional state for the viewer when this was not the intent.

## Traversing the Valley

Attempts to increase realism within the areas of robotics and virtual characters raises the question: *is it possible to overcome the Uncanny Valley?* Brenton et al. suggest that for virtual characters, a viewer's response is likely to change over time; characters will appear less uncanny as viewers grow accustomed to them [4]. Using the example of Duane Hanson's *The Jogger*, Brenton et al. state that the sculpture appears, "less uncanny the second time that it is viewed because you are expecting it and have pre-classified it as a dead object". They also suggest that those involved in the development of realistic human-like characters, or those with a high level of exposure to realistic human-like characters (for example, an advanced experience of playing video games or using 3D modeling software), would be even more accustomed to, and less likely to detect uncanniness from interacting with this type of character. Hanson claims that, whilst very abstract robots or cosmetically peculiar people can be uncanny, it is possible to design against the uncanny for androids [11]. The findings from Hanson's study show that making adjustments to still images of androids across a spectrum of human-likeness, to make androids features more "friendly and attractive", can result in the uncanny being removed from results where it was previously evident. Whilst Hanson notes that the Uncanny Valley is not preordained, the changes Hanson applied to the morphs involved cartoonish, stylized features, as opposed to realistic human-like features.<sup>1</sup> As we explain below, we believe that a traversal of the Uncanny Valley is impossible because of increasing sophistication on the part of the viewer and that the concept of uncanniness for virtual characters is better viewed as an Uncanny Wall.

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<sup>1</sup> This is merely an oblique validation of Mori's theory.

## METHODOLOGY

Our methodology comprises an empirical study using virtual characters and the collection of qualitative data to investigate if the uncanny can be applied to virtual characters, and if so, which factors contribute to the uncanny. In response to Mori's interest in how motion would impact perception (the valley would be even more exaggerated with moving characters) [25], it has been suggested that for recent empirical studies where still images of robots or virtual characters have been used as stimuli, the results might have produced a different outcome had moving images been used as stimuli instead [3] [11] [19] [32]. Our study develops this suggestion by using video clips of virtual characters as the experimental stimuli.

100 participants were used with 92 males and eight females. The participants were mainly university students from the School of Games Computing and Creative Technologies (GCCT) at Bolton University in addition to professionals working within the academic sector and video games industry. Students were selected from the Computer Games Design, Computer Games Software Development and Computer Games Art courses.

Participants were presented with 14 video clips of a selection of virtual characters and one video clip of a real human placed in different settings and engaged in different activities (Table 1). The video clips comprised: six photo-realistic characters; (1) *the Emily Project* [6], (2) and the Warrior by Image Metrics [39]; (3) Mary Smith from Quantic Dream's tech demo *The Casting* [35]; (4) Alex Shepherd from *Silent Hill Homecoming* [34] and two avatars (5) Louis and (6) Francis from *Left 4 Dead* [16]; five zombie characters, (7) a Smoker, (8) The Infected, (9) The Tank and (10) The Witch from *Left 4 Dead* [16], (11) a photo-realistic human-like zombie (Zombie 1) from the video game *Alone in the Dark* [1]; three stylised human-like characters including (12) a Chatbot character "Lillien", [17], (13) Lara Croft from *Lara Croft Tomb Raider: The Action Adventure* [14] and (14) Mario from *Mario and Sonic at the Olympic Games* [22]; and (15) one real human.



Figure 2. The 15 characters used in the experiment, as listed in Table 1.

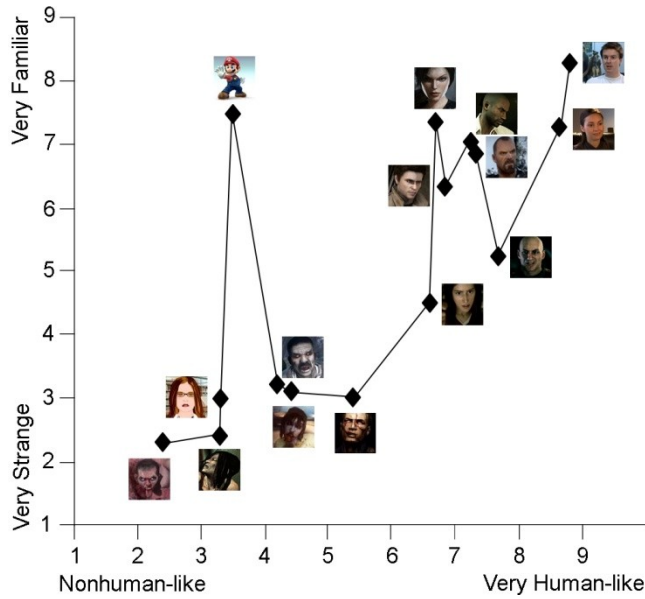
Table 1. The 15 characters used in the experiment, as shown in Figure 2.

	Name		Name		Name
1	Emily	6	Francis	11	Zombie 1
2	Warrior	7	A Smoker	12	Chatbot
3	Mary Smith	8	The Tank	13	Lara Croft
4	Alex Shepherd	9	The Infected	14	Mario
5	Louis	10	The Witch	15	Human

The participants were asked through a web-based questionnaire to rate on a nine-point scale how human-like they perceived the character to be from *nonhuman-like* (1) to very *human-like* (9). To measure the perceived eeriness for a character, participants were asked to rate how strange (eerie) or familiar<sup>2</sup> they perceived the character to be from *very strange* (1) to *very familiar* (9). To measure how behaviour affects perceived familiarity for a character, participants were asked to rate if they agreed with the statement: "Based on the character's appearance, this character behaves in a way that I would expect them to" from *Strongly Disagree* (1) to *Strongly Agree* (9). Participants were also asked to rate their level of experience both playing video games and of using 3D modelling software from the options, *None*, *Basic* or *Advanced*. The video clips were played in random order to each participant.

<sup>2</sup> The appropriateness of *familiarity* both as a term and as a dependent variable to measure uncanniness has been addressed by previous authors such as MacDorman [20]. Familiarity can be open to a range of interpretations from participants. Whilst *strange* is a typical term for describing the unfamiliar, familiarity might be interpreted with a variety of meanings including how well-known an object appears (that is, it might be a well-known character in popular culture). For this study, it was explained to participants that familiarity described objects that did not appear eerie or odd, as opposed to whether an object was well-known.

## RESULTS



**Figure 3. Mean ratings for how human-like a character is perceived to be against mean ratings for perceived familiarity.**

Figure 3 plots the mean ratings for how human-like a character's general appearance or behaviour is perceived to be against perceived familiarity and reveals more than one single valley in the plot. The mean rating for familiarity was 5.16 ( $\sigma$  2.16) and the mean rating for human-likeness was 5.75 ( $\sigma$  2.11).

**Table 2. Mean values for perceived familiarity and perceived human-likeness for participants with differing levels of experience using 3D modelling software.**

Experience of 3D Modelling Software	Number of Participants	Perceived Familiarity (mean 5.14, $\sigma$ 0.06)	Perceived Human-Likeness (mean 5.77, $\sigma$ 0.09)
None	13	5.05	5.9
Basic	64	5.16	5.7
Advanced	23	5.2	5.7

**Table 3. Mean values for perceived familiarity and perceived human-likeness for participants with differing levels of experience playing video games software.**

Experience of Playing Video Games	Number of Participants	Perceived Familiarity (mean 5.17, $\sigma$ 0.06)	Perceived Human-Likeness (mean 5.49, $\sigma$ 0.3)
None	3	5.11	5.4
Basic	14	5.25	5.9
Advanced	83	5.14	5.17

**Table 4. Mean values of ratings for perceived familiarity, human-likeness and expected behaviour based on a character's appearance.**

Character	Familiarity (mean 5.16, $\sigma$ 2.16)	Human-Likeness (mean 5.75, $\sigma$ 2.11)	Behaviour (mean 6.79, $\sigma$ 0.95)
1	7.25	8.67	8.17
2	4.53	6.63	6.18
3	2.99	3.23	4.25
4	3	5.24	6.09
5	6.38	6.84	6.68
6	5.23	7.68	6
7	3.21	4.19	6.64
8	2.33	2.39	6.88
9	2.4	3.28	6.89
10	3.1	4.43	6.84
11	7.02	7.27	7.15
12	6.8	7.34	7.54
13	8.26	8.8	8.44
14	7.36	6.69	6.92
15	7.48	3.5	7.15

When participants were grouped together under different levels of experience (*None*, *Basic* and *Advanced*), for using 3D modelling software (see Table 2) and playing video games (see Table 3) the results show no significant difference for perceived familiarity and human-likeness for each group.

Table 4 shows the mean ratings for perceived familiarity (mean 5.16,  $\sigma$  2.16) and human-likeness (5.75,  $\sigma$  2.11) for each character, with mean ratings for expected behaviour based on the character's appearance. The Pearson correlation coefficient between perceived familiarity and behaviour was  $r=0.6$ . The results show only "a moderate/marked degree of correlation", (by Pearson's definition) which implies perceived behaviour may have a less significant impact on perceived familiarity, or how uncanny a character is perceived to be, than previously suggested [2] [4] [23] [24] [29] [38]. For perceived human-likeness, the results show that the expectation for behaviour is even less significant ( $r=0.49$ ). This correlation stands for just "a moderate degree of correlation" by Pearson's definition.

## DISCUSSION

Attempts to find an empirical basis for the visual representation of the Uncanny Valley chart risk taking the graphical metaphor too literally. Mori's theory places the pit of the valley at an apparently arbitrary 80-85% on the human-likeness scale (Figure 1). Furthermore, this graphical representation of Mori's theory is very neat and pat, displaying a single valley with smooth inclines. Empirical evidence indicates a more complex picture that seems to be dependent upon more variables than Mori's original parameters of appearance and movement. For



example, MacDorman's findings show the nadir of the valley at approximately 35-40% on the human-likeness scale (about 3.5 on a scale of 1-9) when participants were asked to rate the familiarity of a series of still images displaying the visual morphing of a mechanical looking robot into a human [20]. (The participants' ratings for eeriness of the characters depicted in the images shows a clear inverse correlation with familiarity providing evidence for the accepted equation between eeriness – and related negative emotions such as fear and apprehension – and uncanniness.) While showing a valley-like dip similar to Mori's Uncanny Valley, the noticeable difference in MacDorman's empirically-based graphs is the position of the valley's pit at around 35-40% rather than Mori's theoretical 80-85%. Furthermore, the gradients out of MacDorman's valleys are more gentle than Mori's almost perpendicular gradient. The implication (for still images) is that not only does the degree of human-likeness need to be far less than Mori predicted for an eerie and uncanny sensation to occur but also that feelings of eeriness and uncanniness can be associated to a far wider latitude in human-likeness than the very narrow range (at very close to human-like) that Mori predicted.

When MacDorman brought movement into the empirical equation (with a series of videos of robots ranging from mechanical to human-like), two important results were uncovered. Firstly, graphical plots of mean ratings of familiarity against human-likeness showed no single valley and certainly no valleys of the depth and gradient that Mori suggested. Secondly, notwithstanding a typographical inconsistency in the presentation of the results, median familiarity ratings demonstrate that, in this experiment, robots judged as having the same degree of human-likeness can have a different assessment of their familiarity. This difference is more marked when comparing assessments of human-likeness for robots judged to have the same median rating of familiarity. The lack of any single valley or, indeed, any significant valley, when a robot's appearance is combined with movement is *prima facie* evidence against Mori's Uncanny Valley theory – or at least evidence against the construct of a single valley with increased depth and gradient as character movement is assessed.

The later experiment of Tinwell and Grimshaw described in this paper and elsewhere confirms the complexity and lack of clarity of the Uncanny Valley theory when subjected to empirical evidence [36]. Here, the same 9-point scales of familiarity and human-likeness as MacDorman uses were applied to a 100-sample assessment of 15 characters in videos ranging from digital animation to human. Again, there was no single valley to be found (as demonstrated by Table 3). However, there was one significant valley bounded by the anthropomorphic cartoon of Mario on the left and the photo-realistic Lara Croft character on the right with the nadir centred around 50-55% human-likeness (once more, lower than Mori's prediction of 80-85%). One important difference between this experiment and MacDorman's experiment was the deliberate inclusion of character vocalization as part of the assessment process in addition to appearance and movement (only some of MacDorman's video examples included speech). In attempting to find empirical evidence for Mori's Uncanny Valley theory, the inconclusiveness of these sets of results support MacDorman's suggestion that factors beyond human-likeness (when interpreting how a character looks) contribute to sensations of eeriness and the uncanny.

MacDorman provides movement as one of these factors but points out that the empirical evidence from experiments including this factor are inconsistent with Mori's Uncanny Valley. The inclusion of character vocalizations is potentially another factor. In our experiment, we found strong correlations between perceptions of increasing character eeriness and uncanniness with lack of lip and sound synchronization, with lack of human-likeness of the voice and with increasing exaggeration of mouth articulation while vocalizing [36]. As a factor that might be implicated in the uncanny and its associated perceptions and emotions, in addition to the above work there is a small body of work analyzing the effect of various sonic parameters on emotional states. Works such as that of Edworthy et al. suggest that parameters of sound creating perceptions of movement of the sound source towards the listener increase perceptions of urgency in that listener [5]; Halpern et al. suggest that the likeness of the sound of fingernails scraping across a blackboard to predator sounds or the warning cries of primates is what leads to the nerve-jarring unpleasantness of such a sound (implicit to such a suggestion, in the absence of typical modern human inexperience of such sounds, is a vestigial, primeval collective cognizance of such environmentally illuminating sounds) [10]; and Owren and Bachorowski suggest that primates deliberately manipulate fundamental parameters of their vocalizations in order to directly or indirectly affect their listener's emotions (rather than such sounds having a representational meaning understood linguistically) offering the conjecture that this is how some human vocalizations work (for example, laughter and a baby's cry) [26].

Assessing expected behaviour according to appearance, (the uncanny was exaggerated for a viewer when the character failed to behave in the expected manner), our findings go against popular belief [2] [4] [23] [24] [29] [38]. Our results show only a moderate degree of correlation for the relationship between perceived familiarity and behaviour ( $r=0.6$ ) with the relationship between perceived human-likeness and behaviour of even less significance ( $r=0.49$ ). A stronger relationship between these variables might have been achieved if participants had been asked to observe a particular aspect of a character's behaviour (for example, lip movement or facial expression in the upper part of the face) instead of overall behaviour vis-a-vis appearance. Participants might be more sensitive to such *overall* behaviour based on appearance when interacting on a one-to-one basis with an android [24] rather than watching a virtual character onscreen, which may be regarded as a more passive form of interaction. Further studies are planned to investigate how individual aspects of a character's behaviour may exaggerate the uncanny.

There may well be other factors involved in the Uncanny Valley beyond appearance, movement and sound. As Ho et al. state, "the uncanny valley may not be a single phenomenon to be explained by a single theory but rather a nexus of phenomena with disparate causes" [12]. Furthermore, it seems to be the case that, rather than working independently to create an uncanny sensation, some, if not all, factors, work together. As an example, Tinwell and Grimshaw found that lack of lip-vocalization synchronization increased the uncanny phenomenon – this is a combination of movement and sound – but they also found high correlations between familiarity and human-likeness of the characters' voice and between familiarity and the judgement that the voice belonged to the character [36].

In this last case, the combining factors are at least sound and appearance.

This last assessment (of the voice belonging to the character or not) points to the role of experience as another factor. There is an expectation, based on experience, that, for example, large objects will produce a low frequency sound and vice-versa (think elephants compared to mice or the length and thickness of piano strings), that wooden objects will produce a duller sound than metallic objects and that the sound of an approaching object will intensify. What is interesting here is that participants, presented with similar-sized, 2-dimensional video representations of a range of characters, were able to assess the appropriateness and fit of the voice to the character. This idea of appropriateness of the visual and audio modes to each other may be compared to Laurel's suggestion that the resolution of the modes should match otherwise the artefact will seem "brain-damaged" [15]. The concept of cross-modally matching resolutions is not necessarily limited to the comparative quality of audio and video but can also be applied to other relationships as detailed above – a mouse squeak synchronized to an elephant can, depending on yet further factors, be absurd, comical or just plain wrong.

The human-like stylized characters, Mario and Lara Croft, are widely recognized as icons within the gaming industry, which may have affected how participants rated them on the familiarity versus strangeness scale. Despite being instructed to rate perceived familiarity in regards to how human-like a character is perceived to be, these characters might have been a limitation within the study with participants more likely to rate them as familiar because of how *well-known* these characters are. A further study including human-like stylized characters that are not so easily recognizable might improve the experimental validity of the study.

A lack of anthropomorphic type characters within the study has served as another limitation. Characters with a clearly non-human-like appearance but exhibiting human-like traits, according to Mori's theory, are likely to be placed before the first peak in the uncanny plot and not in the valley due to a more simplistic, humanoid appearance. Including a wider range of anthropomorphic type characters, as well as realistic, human-like characters, is also planned for further study.

## Putting the Uncanny into Context

One important factor governing the appropriateness of this resolution matching is context. As explained above, in one context such juxtapositions when ill-fitting can lead to feelings associated with the uncanny, in another context, they are absurd and potentially comical. For example, intentionally badly dubbed *Chock-Socky* movies or the absurd yet funny sound FX used in Jacques Tati's movies or a host of animated cartoons. This points to the importance of context as a governing force subconsciously providing direction as to how to emotionally react to sensation. Context is the frame within which responses are formed (cf *Framing Theory*). Watching *Young Frankenstein* [40], for example, audiences are likely to laugh rather than scream not solely because of the antics of the monster but also because of the prior knowledge that the film is a comedy (as indicated by posters, reviews, previous experience of the stars' other work and so on). This notion of avoidance of the uncanny through a framing context is complemented by Plantec who uses the theory of cognitive dissonance to explain why cartoon

characters in particular do not lead to sensations of the uncanny [28]. Because cartoons do not attempt to deceive or trick the audience into believing they are real humans, there is no cognitive dissonance and, therefore no feeling of unease. Where character creators attempt to fool the audience that the artefact is indeed human, there lies the risk of cognitive dissonance; audiences find subtle inconsistencies in the character's representation that then militate against the plea to believe in the humanness of the character. Such cognitive dissonance, the inability to square the belief that the character is human with the apprehension of inhuman imperfections in its rendering, is a potential explanation of the Uncanny Valley as Plantec points out. This is similar to Brenton et al.'s use of Gestalt-like theories of presence to explain the Uncanny Valley [4]. The authors describe the theory that virtual reality users make use of two hypotheses; one relating to presence in the virtual world and one relating to presence in reality. A switch between hypotheses or the dominance of one over the other (the foregrounding of that hypothesis) leads to a break in presence (from virtual to reality or vice-versa) and, the authors suggest, this is the cause of the Uncanny Valley. The flaw in this theory is exemplified by the first-person horror genre of computer games – presumably, the uncanny is to be desired simultaneously with presence in the game world. However, it would be possible to modify the theory through the inclusion of further hypotheses and one of these would be the contextual framing hypothesis (*this is a horror game and I expect to be frightened at the same time as being immersed in the game*). This framing hypothesis acts as a governor, foregrounding other hypotheses such that uncanniness is allowed to occur without the break in presence. It is a quantum-like state of cognitive dissonance-consonance.

## The Effect of Habituation

The results of this study imply that a viewer's level of experience in interacting with realistic, human-like, characters does not have a significant impact for how uncanny a character is perceived to be. Viewers with an advanced level of experience using 3D modeling software or with an advanced experience of playing video games, showed only a marginal difference in mean values for perceived familiarity and perceived human-likeness against the overall mean values for perceived familiarity 5.16 ( $\sigma$  2.16) and perceived human-likeness 5.75 ( $\sigma$  2.11) for the 15 stimuli within this study (see Tables 2 and 3). This disputes Brenton et al.'s theory that those exposed to a greater level of interaction with realistic human-like characters may be less aware of uncanny traits [4]. Instead we propose that a generally increasing level of technological discernment on the part of viewers (perhaps at a societal-cultural level) maintains the uncanny; successive developments in the pursuit of realism merely raise the bar of discernment. This discernment relates to the technology used rather than to habituation through use or exposure to any one character.

Minato et al. suggested that the habituation effect may alter a participant's interaction with an android, yet notes that further experiments would be required to test if a participant would become more accepting of an android [24]. We propose that the relationship between perceived acceptance and perceived familiarity would not be significant in reducing uncanniness over time. If the character was perceived as uncanny on first contact, a character's believability is unlikely to increase beyond that of a human, no matter how accustomed to it one becomes. Familiarity may increase slightly as acceptance grows, but this increase would not reduce uncanniness significantly and may



also only be for a temporary period. The flaws that a viewer may have grown to tolerate over time will be exaggerated yet again as soon as the next technological breakthrough for increasing realism is developed, hence reducing the overall perceived acceptance of a character. A viewer is reminded of the flaws in a character, thus decreasing perceived familiarity (Figure 4).

## CONCLUSION

The ameliorating effect exerted by the framing hypothesis may help explain why the empirical evidence presents a more dirty picture of the Uncanny Valley than Mori's clean-cut image. Perhaps it is an explanation as to why the depths of the multiple uncanny valleys indicated by the experiments are not as deep as the one envisioned by Mori. Context, with sound and other factors, may now be added to appearance and movement as factors influencing perceptions of the Uncanny Valley and the greater number of potential outcomes arising out of having more parameters to assess, in addition to the interplay between them, is a likely explanation for the inconsistency with Mori's theory. Certainly, it seems clear that the Uncanny Valley, as Mori envisioned it, does not exist. Rather, it is more useful to think of it as a concept and a spur to developers; the impetus behind a form of Uncanny Turing test (similar testing techniques have already been used for androids [13]). Which brings us to the question: *can the Uncanny Valley be traversed?* We suggest the answer is no; rather than Uncanny Valley, we suggest Uncanny Wall (Figure 4). Furthermore, this wall gets higher because of one other factor that other writers have included as an element of habituation. This factor is time. However, whereas Brenton et al. (and others) suggest that audiences, over time, become used to and accommodate factors that once led to the uncanny [4], we suggest that time leads to an increasing discernment on the part of viewers to technical trickery. This increasing sophistication of discernment is the reason why the wall rises as time passes and it may well be that this discernment is at a societal-cultural level rather than being an individual response. In 2007, Plantec suggested "two more years with luck" for an artificial human character to cross the Valley [28] and, in 2008, hailed the Emily character (which was used as one of the videos in our experiment) as having achieved that [27]. Yet, the experiment we describe here shows that character judged consistently as less familiar than the video of a human being. While the difference was slight, we intend to re-run the experiment with the inclusion of the next-generation of virtual human as it is released. If our theory of the Uncanny Wall is correct, we expect the familiarity difference between Emily and human to increase because the participants will have become more discerning in their assessment and therefore more able to recognize the technical trickery that attempts to persuade of the humanness of the character.

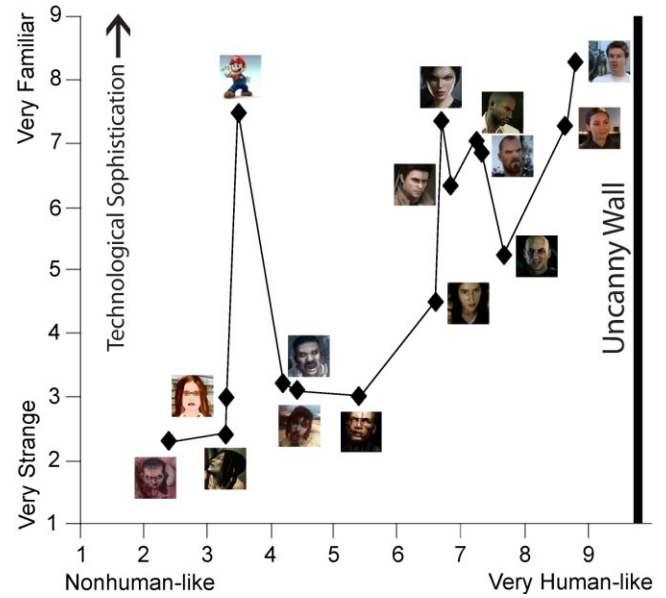


Figure 4. The Uncanny Wall.

Accordingly we present the theory of the Uncanny Wall (represented in Figure 4) as:

*technological discernment on the part of the audience generally keeps pace with technological developments used in the attempt to create realistic human-like characters such that, ultimately, the perception of uncanniness for such characters is inevitable.*

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